

Hanok Preservation: Aluminum as a Solution

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One of the most shocking events in South Korean cultural history was the destruction of Sungnyemun Gate in 2008. As Korea's No.1 National Treasure and one of Seoul's oldest historic gates, built around the 1300s, it has been the passage of the nation's identity until the tragic fire incident. The start of this fire was when a 69-year-old arsonist walked up to the second floor of the gate and ignited the paint thinner he sprinkled on the floor. Although the initial fire was extinguished promptly, the reignition severely damaged the "Hanok" structure of the gate, encompassing the wooden structure and painted walls. The profound destruction has urged national debate on strengthening the protection and preservation measures of historical sites. As this story of the Sungnyemun Gate calls attention to the apparent need for a refined cultural preservation and restoration effort in Korea, this paper review delves into aluminum as an innovative material that can help preserve vulnerable cultural heritage like hanok at risk of deterioration. Existing research on hanok predominantly focuses on the problems of its structures rather than addressing novel proposals and applicable solutions that can improve its restoration projects. By uncovering the link between the benefits of using modern green architecture like aluminum and its potential application on hanok structures, the paper review emphasizes the significance of prioritizing and balancing traditional values and modern innovation to conserve cultural heritage from future damage.

Keywords: South Korean Cultural History, Heritage Preservation, Cultural Restoration, Hanok, Modern Green Architecture, Innovative Materials, Aluminum

Introduction

The term hanok, made by combining two Chinese characters, han (韓, meaning "the Korean people") and ok (屋, meaning "house") is commonly defined as the "House of Korea¹." Typically consisting of a wooden framework, hanok used to function as more than merely a home in the past; in fact, it was the representation of one's social status and wealth. The main components of hanok are materials that are easily found in nature, such as wood, clay, and "hanji" (traditional Korean paper that is made from the bark of the mulberry tree).

With the expansion of cities and the construction of concrete jungles, hanoks are now mostly clustered in small regions of the cities or countryside, forming hanok villages. These villages not only present the enduring architectural elegance of hanok but also the rich cultural heritage of Korea that has continued since the ancestral period. Recently, however, these hanok villages, which were supposed to stand as the cultural heart of Korea, have faced severe challenges. Despite the aesthetic beauty of hanok, preserving and restoring hanok structures have been undesirable due to the high cost compared to the modern convenience and environmental durability of the wooden structures. In particular, the vulnerability to fire and seasonal weather conditions of heavy rainfalls and snowfalls of Korea have replaced hanok structures with the convenience of modern architecture, consequently failing to preserve the authenticity of the historical heritage. As a

result, with the rapid modernization and urbanization of cities in Korea, hanok villages were inevitably demolished and replaced with Western-style buildings using steel and concrete, which disrupted the authenticity of the wooden frames of hanok structures. As a result, with the rapid modernization and urbanization of cities in Korea, hanok villages were inevitably demolished and replaced with Western-style buildings. This was not an exceptional case, even for Seochon, a neighborhood "designated a Hanok Preservation Area in 2010³." The Seochon residents claimed that the whole town had changed so much that they could not find their way around the village. The escalating cost of land is the leading cause behind the demolitions of hanok buildings. Instead of preserving hanoks, "Western-style houses are built to increase usability" of the expensive real estate².

Nonetheless, the Korean government has put constant effort into restoration projects in order to restore the traditional and original hanok structures. Unfortunately, many of these restoration projects have failed to meet public expectations. According to a recently published news article discussing the value of restoration projects in Korea, there has been a claim that it is nearly impossible to restore the whole hanok structure to its original state; in the worst case, the restoration project might cause further damage to the cultural heritage³. Consequently, new innovative solutions are needed to preserve the original stability of hanok and reduce its vulnerability to various factors that may cause damage.

In pursuit of preserving and restoring hanok, traditional Korean architecture, incorporating aluminum as a primary restoration material is a novel resolution that can offer a sustainable and increasingly popular solution aligned with modern green architectural practices. In other words, this review delineates new findings that aluminum can ensure the longevity of the cultural heritage of these historic structures while engaging in contemporary environmental practices. By balancing the modern and the traditional, this new approach in substituting and incorporating novel materials provides a positive innovation in preserving historical buildings.

Methodology

For the comprehensive review of the preservation of hanok through innovative materials like aluminum, the search strategy employed was a systematic approach to exploring multiple reliable databases and online resources and gathering relevant information on the subject. The main keywords and search strings involve “Characteristics of Hanok,” “Hanok Restoration,” “Aluminum in Wooden Architecture,” and “Cultural Heritage Restoration in South Korea” to retrieve the most relevant literature on the subject. The article selection process included the following criteria: 1) Articles published from 2008 to 2023, 2) Articles focusing on Hanok characteristics for both traditional and modern contexts, and 3) Articles focusing on the role and application of aluminum in general and in the context of wooden structures. There is a final selection of a total of 14 articles for a thorough review and synthesis of the argument of the review. The selected articles provide both an overview and details of 1) The characteristics and limitations of hanok and 2) The Properties, benefits, and challenges of incorporating aluminum, helping synthesize information about integrating modern materials like aluminum into traditional Korean architecture like hanok.

Characteristics of Hanok

The construction of the first traditional structure of hanok dates back to Joseon Dynasty (1392-1910). Compared to the majority of foreign household structures during the era, hanok’s efficient architectural function seamlessly reflects the wisdom of our ancestors. In particular, one of the most unique aspects of hanok is the ondol system. “Ondol” “is an underfloor heating system that originated in homes in northern regions with continental climate⁴.” Although it is commonly understood that wood cannot be placed near the ondol system due to wood’s vulnerability to fire, Korea’s climate pattern (presence of both summer and winter air) allows these two structures to coexist. Our ancestors were able to survive the cold winter in the past through the ondol system, which allows heat to be transferred across the entire room. Another unique property of hanok is that

it utilizes clay on the walls and the roof, which ensures that the hanok remains “cool in the summer and warm in the winter with its innate heating and cooling properties⁴.”

Besides its environmental benefits, hanok is also renowned for its diverse structure and design. The structure of hanok differs in the layouts: U-shaped, L-shaped, square, and straight-lined. These layouts have their own advantages. For example, the square layout effectively maintains the room’s warmth; thus, it was preferred in the north, where the weather is colder. On the other hand, families who preferred a larger yard rather than a larger room would choose the L-shaped layout. Thus, the architectural trends of the hanok in the Joseon Dynasty prioritized harmony by utilizing natural sources like wood and clay and forming spatial layouts reflecting the values of the family and spiritual norms of society.

However, these traditional trends, layouts, and structures of hanok are no longer confined to the values and trends of the Joseon Dynasty. There is a much broader range of choice available as “the hanok of 21st-century Seoul tend to be designed to offer greater versatility and to perform a wide variety of functions, public and private, more effectively, as well as to better meet the occupant’s residential and commercial needs⁵.” Meeting structural requirements such as the ondol system and clay structure, 21st-century hanoks have been introduced as an alternative to traditional hanok structures that can better suit modern people’s lifestyles, prioritizing design functionality and durability. While both eras reflect the cultural significance of hanok structures, given the emergence of new forms of hanok, contemporary hanoks often neglect the authentic harmony of nature and spiritual elements. Therefore, preservation and restoration projects of hanok question critical concerns on the balance of traditional purpose and modern efficiency, particularly when deciding how to integrate innovative materials like aluminum into the overall existing structures of hanok.

The Role of Aluminum

Aluminum is one of the most popular materials that has captured the attention of many companies as it aligns with the trend of modern green architecture. Terms such as “green building” and “green architecture” have appeared to prepare for the upcoming challenges of climate change. The fact that “aluminum alloys perfectly meet all the requirements for non-toxic and recyclable building materials” makes it suitable for the rising trend of modern green architecture⁶. In fact, aluminum began to play a significant role in the field of architecture in the 1950s and 1960s when it was combined with “glass and composite plates” to play “additional roles as structured elements of the building facades⁶.”

Aluminum’s infinite recyclability allows it to be recognized as an environmentally friendly material. While it is true that other materials, such as plastic, can be recycled by washing, shredding,

and melting, it takes a relatively long time and a considerable amount of energy to do so. According to an article published in *Forger Recycling*, the typical amount of time needed for plastics to decompose completely takes around 20 to 500 years⁷. On top of that, a million joules of energy are needed to produce plastic substances. On the other hand, aluminum can be recycled infinitely “using only 5% of the energy required for its primary production with electrolysis” and takes around six weeks at most⁸. The stark contrast between aluminum’s energy and time consumption and plastic’s reveals why aluminum appeals to many architectural companies worldwide.

Another major beneficial characteristic of aluminum is its thermal conductivity. Since aluminum has excellent thermal conductivity, it is suitable for regulating temperature inside buildings. While “functioning more ecologically,” aluminum is capable of providing “improved comfort and better control of temperature and natural lightning⁶.” The thermal efficiency of aluminum has resulted in its application to rainscreen facades. Therefore, aluminum possesses numerous favorable attributes as a leading material for modern green architecture. However, using aluminum raises concerns regarding the full life cycle of the material, in particular, the initial environmental footprint. While aluminum is highly recyclable, “global aluminum production accounted for the equivalent of 1.2 billion tons of carbon dioxide emissions in 2021⁹.” Other wastes that pollute the air include “particulate matter, fluorite compounds, sulfur dioxide, hydrogen sulfide, and multi-ring aromatics” that cause harmful impacts on the well-being of the environment and human health¹⁰. Consequently, the producers of aluminum must consider improving its production process to match its highly desirable choice as an alternative and innovative material for preserving historical architecture and building contemporary buildings.

Applications of Aluminum

While the traditional structures of hanok have maintained their original form for many years, they have suffered various damages due to environmental factors and the natural corrosion of wood, which composes the main frame of the hanok. Furthermore, modern residents have identified that hanok requires further improvements to meet the standards of contemporary households. Therefore, integrating aluminum and traditional hanok shows potential synergy that can resolve the existing problems of hanok.

The first potential area for the application of aluminum on hanok is in its overall framework, which is composed of wood. Although the wooden frame of hanok has played a pivotal role in maintaining its architectural stability, “wood structures cannot stand intact over time¹¹.” What’s more important is that even minor damage to the hanok frame can cause severe consequences on the overall stability of hanok. To address this concern, aluminum can potentially serve as a new component of hanok

frames. Aluminum resists corrosion and flexibility, ensuring resilience and extending the original hanok’s life span. Moreover, aluminum can diversify the hanok design by being applied to construct sturdy windows and roofing systems. This innovation can accommodate modern functionality and efficiency issues of hanok. Thus, the combination of modern materials and traditional infrastructure can lead to a significant improvement in hanok architecture.

The second potential application of aluminum on hanok is on its ondol system. For a long time, the ondol system has been an effective heating system that Korean ancestors used to survive harsh winters. Although no critical damage is observed in the ondol system of hanok structure in general, there are perceived disadvantages to using such a heating system. For modern-day people accustomed to advanced technology, hanok’s ondol system can be an inconvenient form and function of a household. For example, the ondol system requires a long time to heat the entire room, consisting of stone and mud. This issue, however, can be addressed by aluminum’s effective thermal conductivity. Developing a modern ondol system combined with aluminum as its primary material could contribute to a more efficient temperature control system for hanok buildings. Since this application of aluminum resolves the modern-day challenges associated with hanok, hanok will eventually become a much more approachable type of residence for people.

The third and arguably the most significant advantage of incorporating aluminum into hanok comes from its positive environmental impacts. The traditional components of hanok are materials that can be easily found in nature. However, the reliance on wood as a primary building material introduces a contradiction, as it inevitably requires the cutting down of trees. According to a paper published in SSRN, the type of tree that is commonly used for the construction of hanok is the red pine, as it represents “longevity¹².” Although the usage of red pine trees in hanok is not the main reason, they have recently faced a drastic decrease in their number. To address this problem, aluminum can replace trees (red pine) as a primary component of hanok. Given that aluminum can be recycled infinitely and has been recognized as a material that perfectly suits the purpose of green architecture, it can serve as an environmentally friendly component of hanok. Even the slightest application of aluminum on hanok can reduce the annual deforestation number of red pine trees.

As a result, the strengths and drawbacks of the properties of the two elements are interchangeably supported to produce an innovative solution to preserving hanoks. Wood’s vulnerability to environmental damage can be eliminated by aluminum’s high durability and resistance to corrosion, making hanok more sustainable. Likewise, aluminum’s high thermal conductivity can be alleviated by wood’s stable temperature regulation throughout the changes of the four seasons in Korea. Yet, as the two elements have an entirely different composition, the joining tech-

niques of wood and aluminum are not as simple. The technical challenge to consider when integrating aluminum into wooden structures like hanok is the extreme amount of heat required to melt it¹³. Moreover, the thermal expansion difference may possibly bring disjoint or incompatibility when combining the two materials.

However, the heated liquid of aluminum burns the side of the wood, which aesthetically blends harmoniously with its black color. Likewise, the relatively seamless application of modern aluminum to wooden structures would not disrupt the traditional aesthetics or taint the cultural significance of hanoks. Besides the enhanced delicate preservation, the use of aluminum helps address issues of the durability of wooden structures and delivers modern functionality and flexibility to the spatial structures of hanok architectures. Aluminum ultimately helps provide a rigorous foundational structure of hanok, an essential aspect of preservation and restoration projects. Without exception, all basic structures of hanok, including roofs, pillars, and beams, could be restored with more durable materials like aluminum to withstand the harsh changes of the four seasons. This would help reduce repairs and increase the longevity of hanoks, especially against environmental aspects like the heavy rainfall and snowfall in Korea that have been existing weaknesses in traditional hanok materials. Hence, integrating aluminum into wooden structures has the benefits of preserving cultural values and delivering modern functionality; most crucially, it is not completely impossible.

Balancing Tradition and Innovation

While it is true that the three proposed applications of aluminum on traditional hanok structures have the potential to enhance longevity and stability as well as attractiveness to modern residences, it is crucial to prioritize the preservation of hanok's historical and cultural value prior to implementing such alterations to the structures. In our society, there is a general consensus that "any building that carries historical significance must be carefully preserved in every way possible¹⁴." This consensus holds true because all historical constructions are part of the country's rich cultural and historical heritage. Particularly for the hanok architecture, which is deeply rooted in Korean tradition and philosophy, changing its main components may be perceived as an erosion of cultural continuity. Another concern that may arise regarding the application of aluminum is the need for extensive time and effort to develop a new technique to make replacements flawless and possible. In the case of hanoks, the old structures would need to undergo an immense process of disintegration to apply such new aluminum techniques.

Nonetheless, blending modern eco-friendly materials like aluminum with the traditional aesthetics of hanok structures can maximize the potential benefits of modernization in historical preservation by supporting the longevity of hanok against en-

vironmental factors. This eliminates the existing weakness in traditional hanok materials. Moreover, although the idea of combining aluminum with hanok still remains an unfamiliar concept to the public, especially within the Korean community, where preserving culture and tradition is highly valued, aluminum presents an alternative and innovative solution. This approach allows for proactive measures before hanok structures reach the point of rapid and complete demolition. Thus, the integration of aluminum does not imply that hanok will lose its cultural significance; instead, it presents us with an opportunity to cultivate an "innovative" value through the process of transformation. Regardless of whether the replacement involves adopting aluminum or other environmentally friendly and innovative materials, one thing is certain: a different and creative change must occur to safeguard hanok structures from further harm, resulting in a complete loss of cultural significance in the future.

Limitations and Future Suggestions

The review of the application of aluminum to the hanok structure outlines the potential benefits of innovative modern materials in preserving the cultural heritage of architectural remains, especially in the context of wooden structures of hanok. As there are critical concerns about preserving the cultural and aesthetic significance of wooden structures and the high cost and maintenance of wooden materials against the distinct seasonal changes in Korea, aluminum could be a key change in the outdated preservation of wooden structures. However, the review lacks an empirical and factual database, as there was limited to no access to reliable projects that have been officially conducted in settings similar to hanok. In particular, the review's innovative suggestion of incorporating aluminum into existing wooden structures has yet to be explored by the organizations. This limitation of the review, however, only intensifies the argument for the need for increased investment and research in innovative materials and cultural preservation.

Researchers, engineers, architects, and conservationists in respective fields should invest in discovering more innovative and sustainable materials that can bridge traditional architecture with modern necessities without hindering the historical authenticity and values of the buildings. Governments, organizations, and communities should come together to encourage the application of standardized guidelines for adopting and applying materials like aluminum to preserve traditional architecture. In particular, exploring the limitations and needs of the local community and environmental conditions would help enhance the application process of aluminum to hanok's wooden structures. Moreover, scientific communities should contribute to inventing technologies and improving techniques to help implement and incorporate contemporary materials like aluminum into traditional structures like hanok.

The overall increase in studies will help raise awareness and initiatives to incorporate innovation to preserve history. Above all, more focus must be placed on reducing the initial carbon footprints of producing modern materials like aluminum. Despite the benefits of incorporating modern materials in preserving historical heritage, the efforts would be meaningless or defeat their purpose if more damage were done to the production process of the materials, as preservation effort is based on the ethics of conserving the existing beauty, culture, tradition, and identity of a society. Therefore, promoting innovative materials by balancing eco-friendly design solutions is necessary to conserve historical structures like hanok.

Conclusion

In conclusion, this review has shed light on the potential benefits of historical and cultural restoration projects by incorporating innovative materials like aluminum into hanok structures. As discussed throughout, the unique properties of aluminum, such as its flexibility, resistance to corrosion, and thermal conductivity, make it a promising material to extend the resilience and longevity of traditional hanok buildings. The potential of aluminum eliminates the concerns in traditional hanok materials and structures, particularly during the process of preservation and restoration. As possible drawbacks are associated with applying aluminum to wood due to potential incompatibility in material composition and hurdles of the distinct weather conditions in Korea, more factual and empirical research needs to be conducted to determine the feasibility of incorporating modern materials like aluminum into hanok structures. The argument of the review is grounded on thorough research and reasonable assumptions by comparing the potential of combining aluminum and wood. Embracing aluminum ensures the continued sustainability and longevity of hanok and showcases the harmonious existence between historical tradition and modern progress. While embracing the preservation of the past, such innovative changes can simultaneously embrace the possibilities that lie ahead.

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